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December 24, 2002

Mr. John Mannle, Assistant Engineer  
Plumas County Department of Public Works  
1834 East Main  
Quincy, CA 95971

Subject: Geotechnical Investigation  
Big Creek Road Washout  
Plumas County, California

1P1/302/204

Dear Mr. Mannle:

Transmitted herewith is our report of geotechnical investigation performed at the above site in accordance with your request. As questions arise concerning subsurface conditions during planning and design, please call on us.

This report presents a discussion of roadway repair options and is intended to provide a basis for planning and preliminary engineering design. Final design may require further study, depending on the selected option and level of repair. For some options, geotechnical construction observation/consultation would be a significant element of repair to verify anticipated materials/conditions.

We have enjoyed this opportunity to be of service.

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R. D. Sowers

RDS/ns

Distribution: Client (4)



GEOTECHNICAL INVESTIGATION

Big Creek Road Washout  
Plumas County, California

County of Plumas - Owner

1P1/302/204  
Location: 39121-H1:094N:270W

December 2002

**GEOTECHNICAL INVESTIGATION**Big Creek Road Washout  
Plumas County, California

1P1/302/204

**Introduction**

A limited study of subsurface materials and conditions has been completed at the above site in accordance with the agreement between the County of Plumas and Taber Consultants. The purpose of this study is to provide preliminary geotechnical criteria in support of planning and preliminary design of appropriate remedial work. Limitations of this study are discussed in the attached "General Conditions".

**Site Description**

Big Creek Road at this location traverses a steep southeast-facing slope approximately 50 ft above Big Creek. The road in this area is in a combination cut/fill section with inboard cuts generally 20-30 ft high, but as high as 70 ft (large cut immediately north of the project). Outboard fill includes "sliver" fills, loose cast-over fill, and a through-fill in the vicinity of an existing 18 inch CMP (at Project Station 277+45, within area of primary slope failure).

Big Creek at this location flows generally northerly and impinges sharply into the bank near the 18 inch CMP. The fill in this area has failed, damaging and exposing much of the CMP and down drain. An older, underlying CMP is also exposed by the washout. Bank undercutting has affected a 200±ft section of the lower bank, extending approximately 100 ft either side of the CMP. The embankment slope within the failed area is very steep – overall about 1:1 but locally near-vertical.

At road level, the fill failure has encroached to the edge of pavement along a 60±ft section (road length) to both sides of the CMP (between approximate project Sta. 277+30 to 277+90). Lesser fill failure is occurring along much of the outboard section extending 100±ft south of the CMP (to about Sta. 276+45). About 100 ft south of the CMP, the pavement shows evidence of local resurfacing with cracks. A prominent

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transverse crack crosses the road approximately 40 ft north of the CMP, near Sta. 277+90 (near the cut/fill line).

### **Study Procedures**

Office study included review of published geologic information and the Project Study Report. Field work included geologic reconnaissance of the immediate area and three augered/rotary sampled test borings extended to maximum depth 70 ft below road grade.

"Undisturbed" samples were recovered from the test borings by means of a 2.0 inch OD "standard penetration" sampler advanced with standard striking force (350 ft-lb weight falling 30 inches per ASTM D1586) to provide a field estimate of soils consistency. Selected "undisturbed" samples were retained in moisture-proof containers for laboratory testing and reference.

Earth materials were field-classified as to consistency, color, texture and gradation by a geologist on the bases of penetration resistance, examination of samples and inspection of auger/drill cuttings. Laboratory testing on "undisturbed" samples included moisture content-dry density and unconfined compressive strength determinations. Groundwater observations were made in the borings during drilling and after completion of field operations. The borings were backfilled with native soil cuttings and patched with asphaltic cold-patch.

Boring locations and elevations are referenced to 1"=40' scale site topography (dated 8-29-02) prepared by Plumas County. Locations, elevations, details of borings and results of tests are shown on the attached "Log of Test Borings" drawing. R. C. Pickard was field engineering geologist for this study.

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### **Geologic Setting**

Site geology is mapped in this area as Paleozoic-age Calaveras Complex, comprised of chert, argillite and slate, with lesser areas of metavolcanic rock. Review of cut slope exposures is consistent with this designation, varying from highly weathered mica schist to hard, foliated phyllite, slate and quartzite. Rock bedding and foliation planes strike northwesterly and dip nearly vertical. Foliation planes within the large cut north of the project limits were measured at N40W, 82SE.

The existing slopes are at approximate 1:1 slope, with steeper sections in hard rock areas and somewhat flatter sections where general sloughing has occurred. The areas of relatively hard rock (chert, slate, quartzite) are generally stable at slopes as steep as 1/2h:1v, whereas the zones of highly weathered rock (schist and other metavolcanic rock) have experienced generally sloughing to slopes on the order of 1 1/4:1 (but appear otherwise stable).

No landslides are shown on the published mapping, nor was evidence of such observed as part of this study. The topography above the road in the CMP area (near Sta. 277) appears to be a natural draw and may reflect a subdued old landslide feature, but no evidence of recent movement was observed in this area.

No faults are shown on the published mapping to cross the site. The nearest mapped faults are the Rich Bar fault and the Melones fault zone, located northeast by approximately 1.5 miles and 4.8 miles, respectively. Both of these faults are indicated to have segments displaying Quaternary activity and are classed as potentially active.

### **Earth Materials/Conditions**

Materials encountered in the test borings are divided into three units considered significant to roadway stabilization efforts. The uppermost unit was encountered from road grade to depths of 3 ft, 18 ft and 13 ft in B-1, B-2 and B-3, respectively (south to

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north). Materials of this unit are described as mostly compact silty and sandy gravel and are identified as predominately fill. This unit is largely exposed by the bank washout and is over-steep, generally unstable in its present condition, and subject to erosion where exposed.

The middle unit was encountered in each boring to depths of 5 ft, 39 ft and 33 ft in B-1, B-2 and B-3, respectively. Materials of this unit are described as mostly semicompact to dense silty and sandy gravel with rock fragments and occasional organic material. This unit is identified as slope colluvium and is considered relatively stable but subject to erosion where exposed.

The lowermost unit was encountered in each boring below the middle unit to the maximum depth of exploration (71 ft). Materials of this unit are described as predominately phyllite with variable weathering and thin, near-vertical foliation planes. These materials were drillable with rotary drill methods to the indicated depths, but experienced near-refusal at depths of 27 ft (B-1) and 42 ft (B-3). These materials are consistent with weathered metamorphic rock as locally exposed in the road cuts and designated on published mapping. The rock unit is considered generally stable and relatively erosion-resistant, although the highly weathered portions are susceptible to erosion where exposed.

No free groundwater was encountered in the test borings for this study (drilled October 2002). The upper unit soils are expected to be seasonally saturated and out-of-slope seepage -- especially along the interface of the middle and lower units -- is likely along the slope area during the winter months. Groundwater within the rock unit may be locally/seasonally significant, but is expected to be generally restricted to planes of weakness (e.g., highly weathered zones and predominant bedding/foliation planes).

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### **Conclusions**

On the basis of the foregoing, it is concluded that the subject bank failure occurred primarily within the unconsolidated (largely "cast-over") upper-unit fill as a result of bank undercutting along the base of slope. The bank undercutting is especially severe at this location during periods of high water due to the adverse impact angle of Big Creek. Other factors contributing to slope instability include surface water infiltration; over-side sheet flow during storms and snowmelt runoff; and storm-induced seepage pressures developed within the unconsolidated upper and middle-unit materials. Without remedial work, renewal and extension of movement (both lateral and headward)--with additional roadway involvement--could be expected during future wet seasons.

The area most susceptible to future distress appears to be between approximate Sta. 276+45 and 277+90, where the fill/colluvium is deepest and the creek impacts the slope most adversely. South of 276+45, the road is primarily in cut and the depth of exterior fill is on the order of 5±ft or less. North of 277+90, the road transitions into a through-cut in weathered rock and is not impacted as severely by the bank erosion. The transverse road crack near Sta. 277+90 likely represents the transition from fill to cut, and the estimated northerly limit of potential distress.

Several repair alternatives can be considered for this (preliminary design) stage of the project. For discussion purposes, five options are presented below, including a "do nothing" option. The most appropriate alternative may depend on such factors as acceptable changes in roadway alignment/grade; right-of-way limits/acquisition; levels of appropriate risk; maintenance requirements and costs (both construction and long-term maintenance).

A combination of options may be most cost-effective for a given level of service, including slope re-grading, drainage/subdrainage, outer edge-of-road support and bank

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protection along the base of creek. For the purposes of this report, a high water level at elevation 4920 is assumed (above high water level as indicated in Project Study Report). Further discussion of cost-benefit combinations is anticipated based on this report and the data obtained.

### **Discussion of Options**

#### **Option-1: "Do Nothing"**

Without remedial work (i.e., "do nothing" approach), the creek is expected to continue to undercut the bank during periods of high flow, resulting in further failure of the fill slope and likely additional loss of shoulder/roadway. The potential for a significant loss of roadway during high creek flow is considered high and may affect the outer lane for a distance of up to 150+ft. The long-term closure of at least one lane may be necessary until slope and weather conditions permit repair. This option is not considered viable unless substantial seasonal maintenance is allocated and restricted winter use can be accepted (i.e., one-lane emergency-access during storm events).

A variation of this option could include improved slope clearances, safety and drainage, but excluding new structures or significant earthwork. Shifting the road inward by 5± ft could likely be accomplished without new cuts, and K-rail could be established to protect traffic from the steep embankment slope. Drainage could include an outside AC dike to control surface runoff, and improvements to the inside road ditch and culverts. This approach may provide adequate "short-term" service, but would not mitigate a large-scale bank failure that could be anticipated during a large storm event.

#### **Option-2: Reconstructed Embankment**

A reconstructed embankment approach is visualized as including removal of the upper unit fill, construction of a heavy rock buttress along the base of slope (extended

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to above high water level), and replacement of the embankment as a drained, engineered fill section. A  $20\pm$ ft shift of the creek away from the bank would be required to "fit" a rock buttress without modifying the road alignment or a typical  $1\frac{1}{2}$ :1 exterior slope. A sketch of this option is shown on Drawing-3.

A minimum 12-ft wide toe bench established about  $4\pm$ ft below channel bottom (into affirmed intact material) is expected to be appropriate for the buttress section. Construction is anticipated at times of low creek flow (i.e., late summer) and excavation inflow is expected to be controllable by pumping/diversion. The exposed base and backslope should be reviewed by a representative of this office to affirm anticipated materials and conditions.

A continuous subdrainage "blanket" consisting of a  $2\pm$ ft thick section of Permeable Materials (per Section 68, Caltrans Standard Specifications) should be placed along the backslope. Filter fabric is recommended around the drain materials to prevent mobilization of fines into the drain system. A perforated drain outlet should be placed near the top of the rock buttress with solid pipe outlet to the creek. Native fill materials (less any debris) are considered suitable for use as compacted embankment, placed to at least 90% relative compaction (per CTM 216).

To control and new embankment, An interceptor underdrain is recommended to extend to depth 6-8 ft along the inner road area to exclude shallow (seasonal) groundwater infiltration/seepage from road subgrade. A 2-ft wide drain consisting of Permeable Materials wrapped in filter fabric is considered appropriate with gravity relief north of the slide area. The surficial  $2\pm$ ft of the underdrain should be "capped" with native clayey soil to inhibit surface infiltration into the drain. The roadway should have an outer berm and overside drain to control surface runoff.

Advantages of this option include maintaining the existing alignment without new cuts and providing protection at the base of slope from future undercutting.

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Disadvantages include significant earthwork effort, disruption of traffic during construction and creek realignment requirements.

#### Option-3: Roadway Retreat

A full road retreat can be considered, with the objective of providing a 24 ft section established behind a 1½:1 "control line" extended from the base of creek. The creek bank would require RSP to control future undercutting. Some existing fill could remain in-place, but road reliance should be maintained behind the control line. A sketch of this option is shown on Drawing-4.

Advantages of a retreat include simplicity and straightforward construction at relatively low cost. Disadvantages include difficulty in maintaining minimum road alignment standards without incurring new high cuts, especially at the north end. New cut into the high existing cut near Sta. 279 would require further study and may require benching for stability and the purchase of significant new right of way.

#### Option-4: Tie-Back Soldier Pile Wall

A soldier-pile wall option can be considered, as sketched on Drawing-5. Boring data indicate suitability of cast-in-drilled-hole (CIDH) piling for use as vertical members with tie-backs for control of lateral stresses. Subdrainage behind the wall would be required to relieve seepage, especially within local rock zones of significant weakness.

Support for CIDH pile elements should extend into the lowermost unit ("intact") rock. Use of 18-24 inch (or greater) CIDH piles would be considered appropriate at 8-10 ft spacing, achieving penetration into the rock unit. Maximum wall height is anticipated to be on the order of 25 ft and tie-backs are expected to be required for control of lateral stresses; use of an H-pile "core" could be considered, as necessary.

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Pile tip elevations would depend on final wall location and realized loading per pile. Drilling of the pile excavations is expected to be achievable with heavy-duty drilling equipment capable of coring variably weathered metamorphic rock. Groundwater inflow is expected to be minimal during dry-season construction and controllable by pumping, as necessary.

Depth of bulkheading should extend to at least the base of the upper-unit fill. A construction backslope of 1:1 is considered appropriate for short-term periods of time. Wood or concrete lagging would be considered suitable for restraining fill materials. Wall backfill behind the bulkheading should be open-graded aggregate (drain rock) with geotextile filter fabric backing. The wall backfill should be fully drained with perforated pipe and gravity outlet at the low point of the wall.

Resistance to lateral forces can be achieved by drilled soil anchors achieving penetration into weathered rock similar to that exposed in the existing cut-slope. For planning purposes, ultimate bond stresses of at least 25 psi are considered available between grouted anchors (bond length) and weathered rock; with 15-20 ft of bonded length, ultimate capacity on the order of 60-80 would be expected to be available for individual anchors of diameter 6 inches. Alternatively, CIDH piles similar to the soldier piles could be utilized along the inside of roadway as anchors, with ties established at depth 5±ft below roadway level. Surface runoff should be controlled and directed away from the slip-out area (i.e., by means of AC dike along outer edge of road).

Advantages of this approach include support generated within the stable lowermost unit rock, relatively minor slope excavation, a degree of independence from subsequent similar events (either downslope or adjacent) and reduced site/traffic disturbance during construction. Disadvantages include anticipated high cost relative to other options.

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#### Option-5: Reinforced Fill/RSP

This option would provide erosion protection at the base of slope by means of an RSP buttress section extended to above high water line, and provide a reinforced fill section suitable for support of the road. A goal would be to maintain the approximate existing alignment without major new cuts or a shift of the creek. A sketch of this option is shown on Drawing-6.

Major elements of this approach include establishing RSP toe support within suitable bearing material; relief of seepage pressures behind the reinforced section; and smooth transition to native slopes at the ends. "Flexible" gravity-wall systems (such as "Hilfiker" welded wire, "Mechanically-Stabilized Embankment", gabion, etc) are also considered feasible and could be considered within this option. More rigid wall systems such as reinforced concrete cantilever or concrete crib walls, while feasible, have limited tolerance to movement and are not recommended for this site.

Major construction elements include:

- Removal of weak upper-unit (fill) soils along line of reinforced section
- Construct secure RSP buttress at toe of slope
- Establish base of wall on stable buttress rock
- Install subdrainage behind the wall, with gravity relief
- Install trenched underdrain along inner road area
- Transition to native slopes at wall ends with independent wall segments, as needed

Site geometry suggests that a reinforced section of length 150 ft and height 30-40 ft will be necessary to achieve project objectives. At each end, transition segments of length 20 ft and height 8-10 ft are expected to be appropriate.

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Advantages of this option include a degree of internal flexibility and relatively straight-forward and economical construction. Disadvantages include the need to excavate large portions of the existing road, requiring staged construction and/or traffic delays during earthwork.

### Summary

The options presented above are for planning and preliminary engineering purposes and anticipate further discussion with respect to geotechnical conditions. Combinations of these options, as well as consideration of other options, can also be discussed from the data in-hand. The most effective repair should consider long-term maintenance as well as initial construction effort/cost. Some options anticipate further (design-level) geotechnical study and/or specific input during construction.

\* \* \* \* \*

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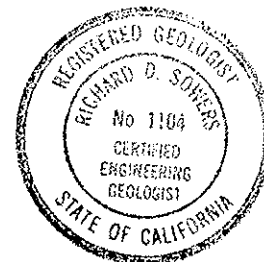
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R.C.E. 38788  
C.E.G. 1104



December 24, 2002

### Attachments:

Figure-1	"General Conditions"
Drawing-1	"Vicinity Map"
Drawing-2	"Log of Test Borings"
Drawing-3	"Cross Sections"
Drawing-4	"Repair Option-2: Reconstructed Embankment"
Drawing-5	"Repair Option-3: Roadway Retreat"
Drawing-6	"Repair Option-4: Tie-Back Soldier Pile Wall"
	"Repair Option-5: Reinforced Fill/RSP"



### GENERAL CONDITIONS

The conclusions and recommendations of this study are professional opinion based upon the indicated project criteria and the limited data described herein. It is recognized there is potential for sufficient variation in subsurface conditions that modification of conclusions and recommendations might emerge from further, more detailed study.

This report is intended only for the purpose, site location and project description indicated and assumes design and construction in accordance with Caltrans practice.

As changes in appropriate standards, site conditions and technical knowledge cannot be adequately predicted, review of recommendations by this office for use after a period of one year is a condition of this report.

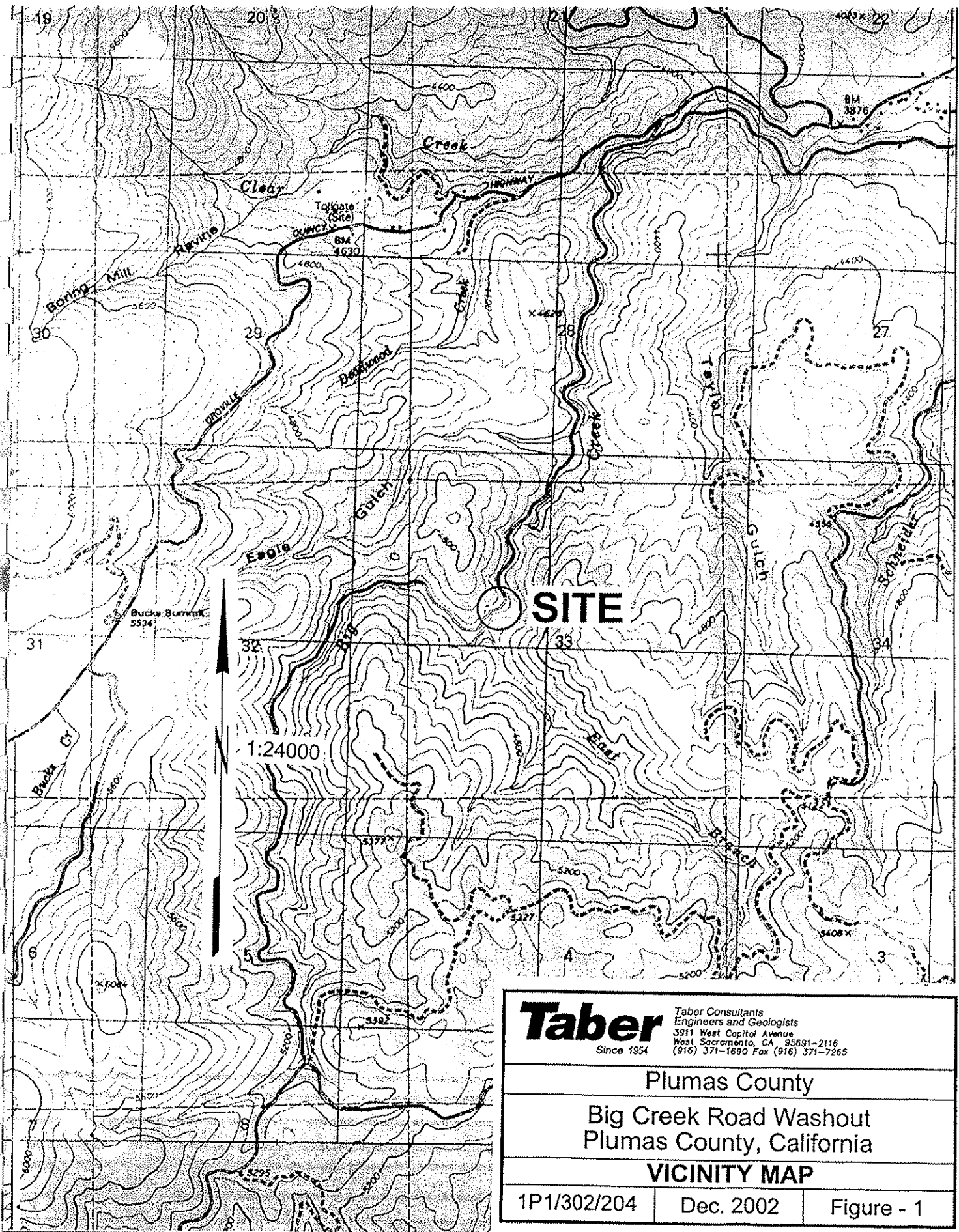
A review by this office of any foundation and/or grading plans and specifications or other work product insofar as they rely upon or implement the content of this report, together with the opportunity to make supplemental recommendations as indicated therefrom is considered an integral part of this study and a condition of recommendations.

Subsequently defined construction observation procedures and/or agencies are an element of work, which may affect supplementary recommendations. This office should observe pile excavations and provide input during construction to confirm anticipated conditions.

Should there be significant change in the project or should soils conditions different from those described in this report be encountered during construction, this office should be notified for evaluation and supplemental recommendations as necessary or appropriate.

Opinions and recommendations apply to current site conditions and those reasonably foreseeable for the described development -- which includes appropriate operation and maintenance thereof. They cannot apply to site changes occurring, made, or induced, of which this office is not aware and has not had opportunity to evaluate.

The scope of this study specifically excluded sampling and/or testing for, or evaluation of the occurrence and distribution of, hazardous substances. No opinion is intended regarding the presence or distribution of any hazardous substances at this or nearby sites.



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Plumas County

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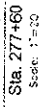
**VICINITY MAP**

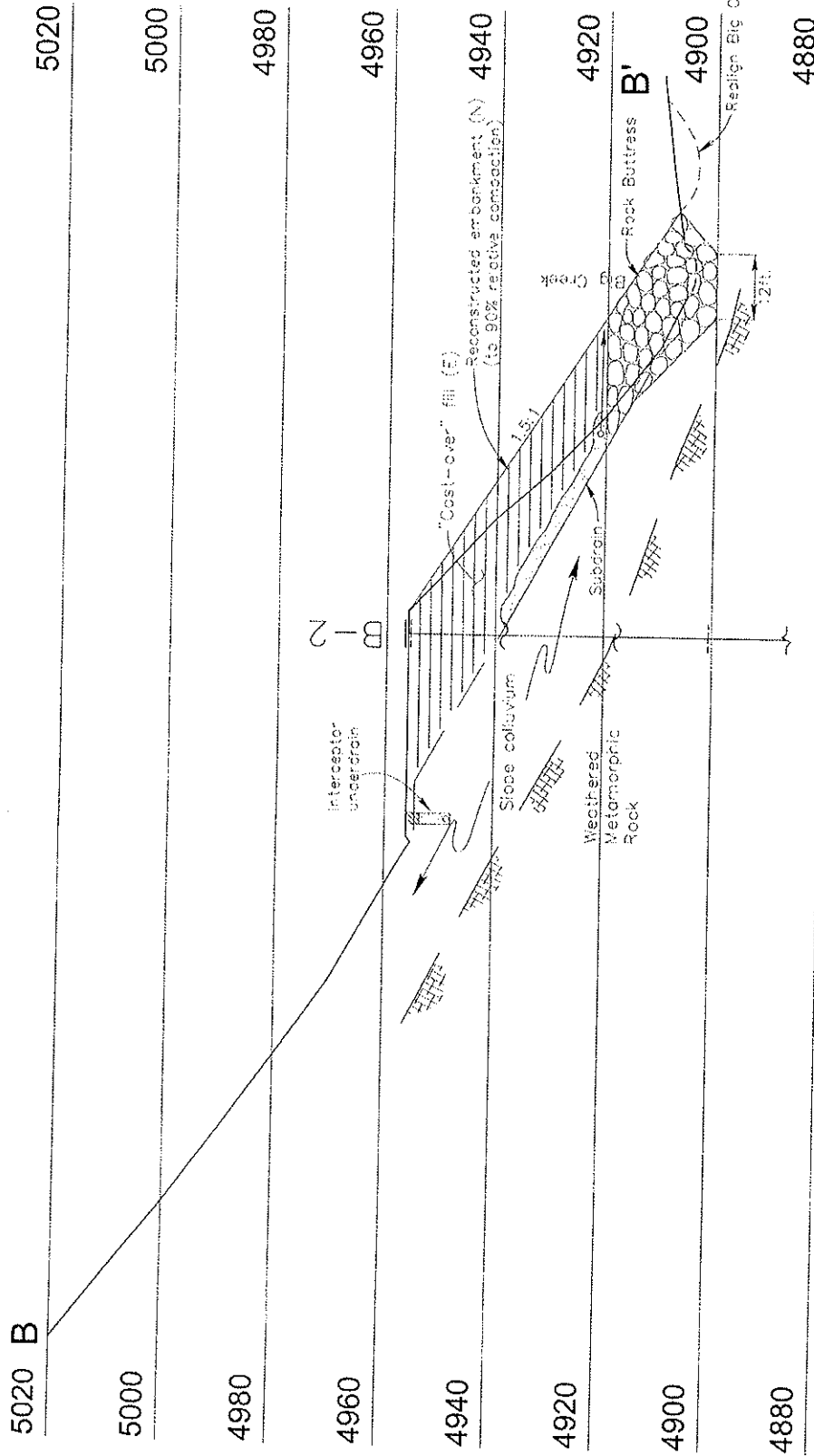
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Figure - 1



Sta. 276+00  
Scale 1"=20'Sta. 276+75  
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Option-2: Reconstructed Embankment  
Section B-B', Sta. 276+75

Scale: 1"=20'

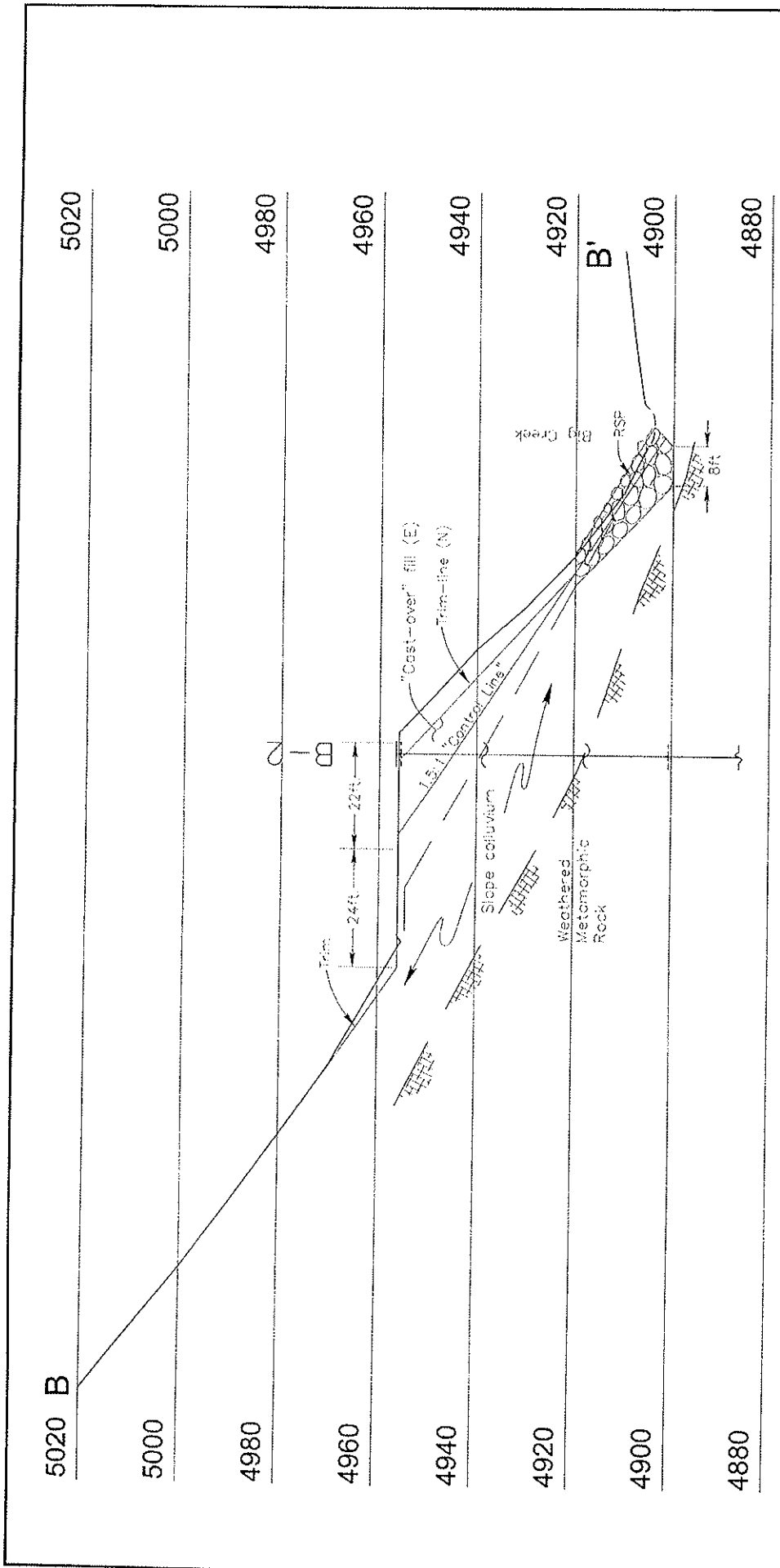
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Plumas County, California

REPAIR OPTIONS

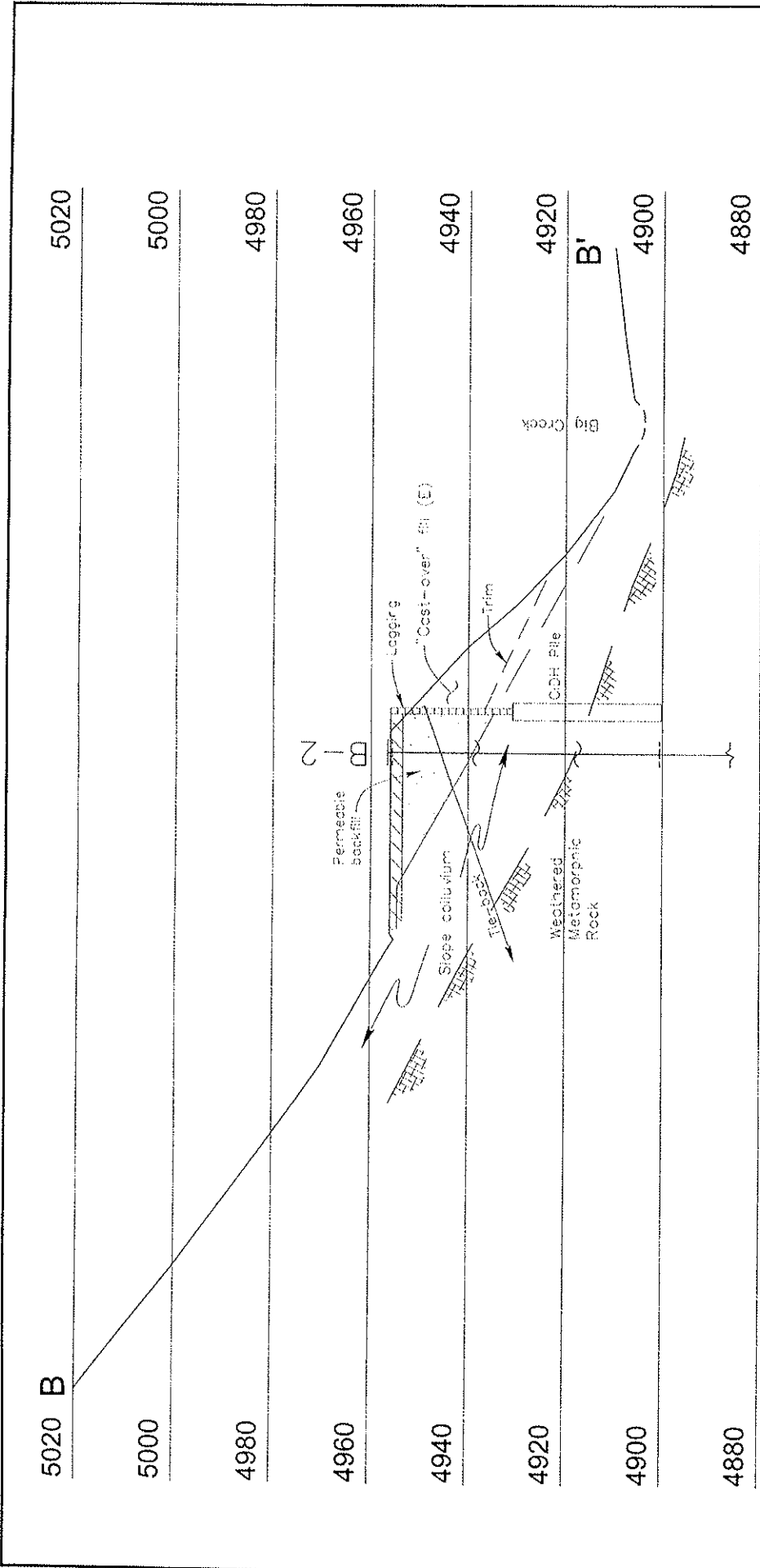
1P1/302/204 Dec. 2002 Drawing - 3



**Option-3: Roadway Retreat**  
**Section B-B', Sta. 276+75**

Scale: 1"=20'

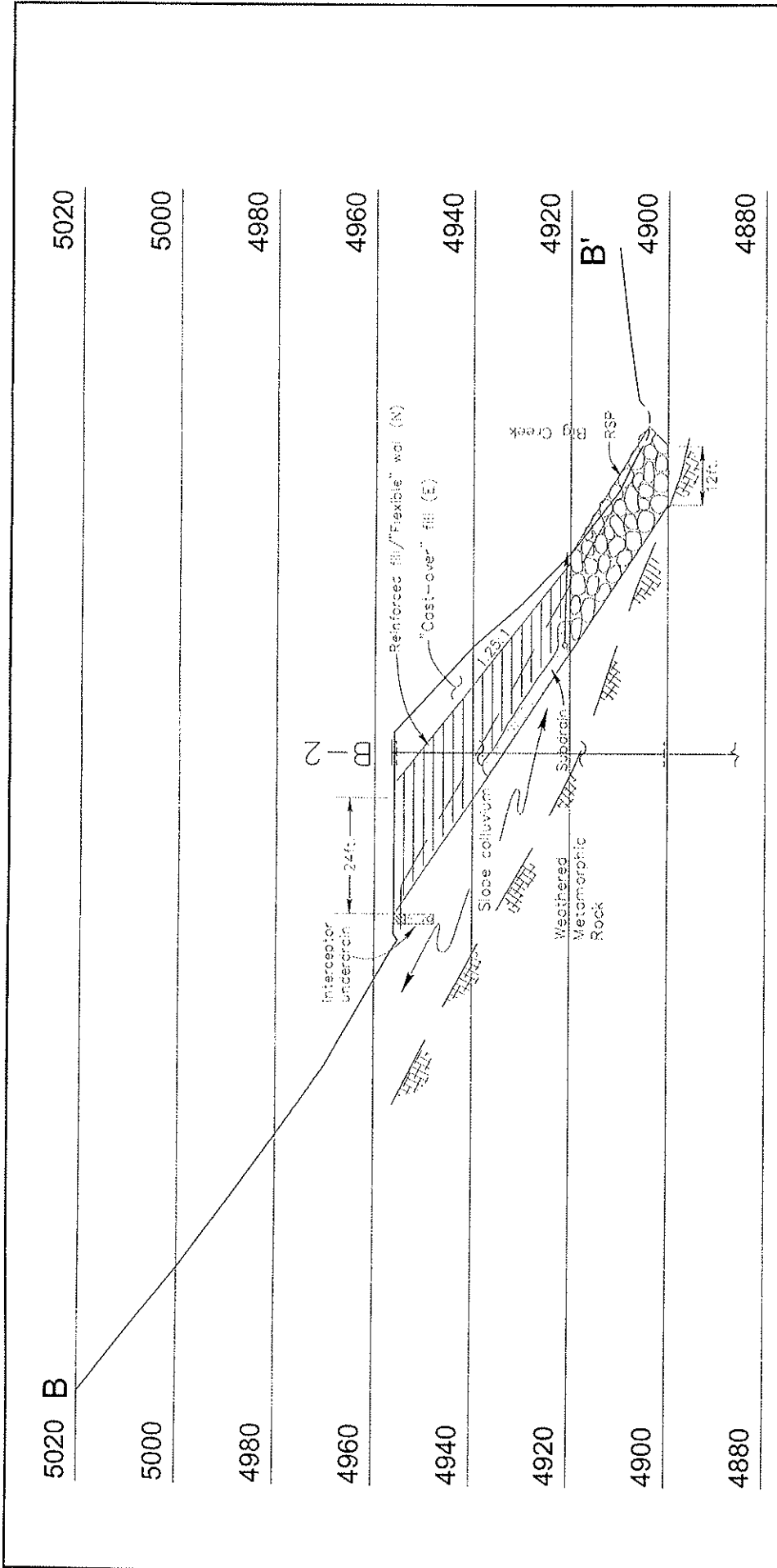
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Option-4: Tie-back Soldier Pile Wall  
Section B-B', Sta. 276+75

Scale: 1"=20'

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Drawing - 5	



Option-5: Reinforced Fill / RSP  
Section B-B', Sta. 276+75

Scale: 1"=20'

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